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Supporting Information

Improved Perovskite Crystallization by Antisolvent Engineering in Tin-Perovskite Photovoltaics

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Table S1. Statistics of photovoltaic performance parameters of tin-based perovskite solar cells.

Year	V_{oc} (V)	J_{sc} (mA/cm^2)	FF (%)	PCE (%)	Ref
2014	0.88	16.8	42	6.4	[1]
2014	0.82	12.3	57	5.7	[2]
2016	0.47	22.07	60.67	6.22	[3]
2017	0.61	21.2	62.7	8.12	[4]
2017	0.53	24.1	71	9	[5]
2018	0.62	21.2	72.9	9.6	[6]
2020	0.84	20.32	78	13.24	[7]
2021	0.84	24.91	70.76	14.81	[8]
2022	0.77	24.9	76.7	14.7	[9]
2022	0.92	20.4	76.7	14.3	[10]
2023	0.91	20.6	78.6	14.6	[11]
2024	0.86	24.81	72.37	15.4	[12]
2024	0.97	21.7	74.1	15.7	[13]

Table S2. Fundamental physical parameters of DMF, DMSO, CB, DMS.

Solvents	Donor number (kcal/mol)	Dielectric constant	Dipole moment (D)	Boiling point (℃)	Vapor pressure at 20℃ (kPa)
DMF	26.6	36.7	3.7	153	0.38
DMSO	29.8	46.6	4.1	189	0.05
CB	3.3	5.6	1.5	132	1.17
DMS	40.0	6.3	1.5	38	53.7

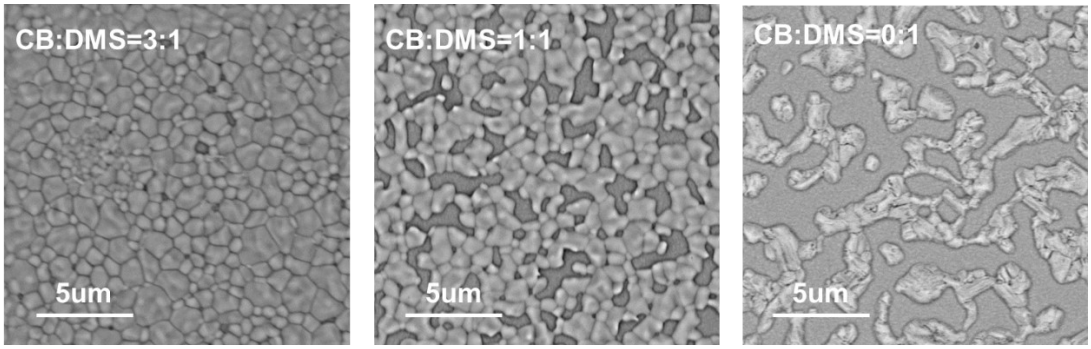

Fig. S1 Top-view scanning electron microscopy images of different ratios of CB and DMS.

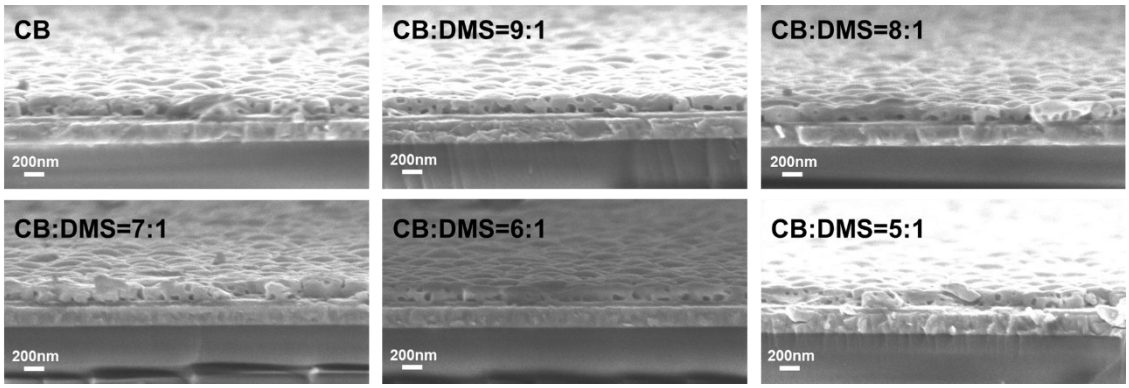

Fig. S2 Cross-sectional SEM images of tin-based perovskite films based on different antisolvent ratios.

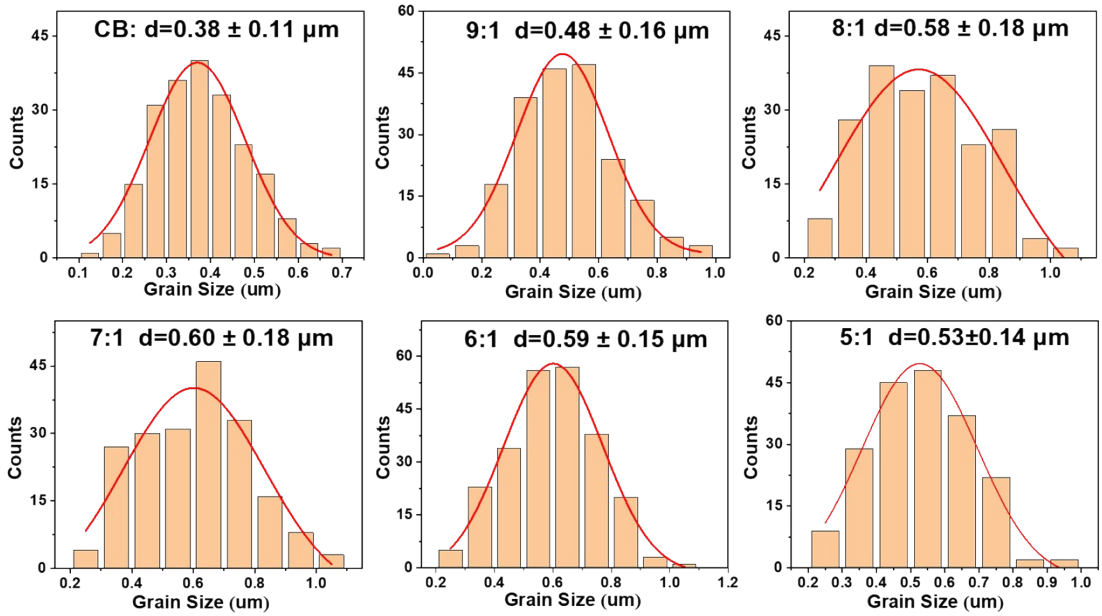

Fig. S3 Grain diameter distribution of tin-based perovskite films with different antisolvent ratios.

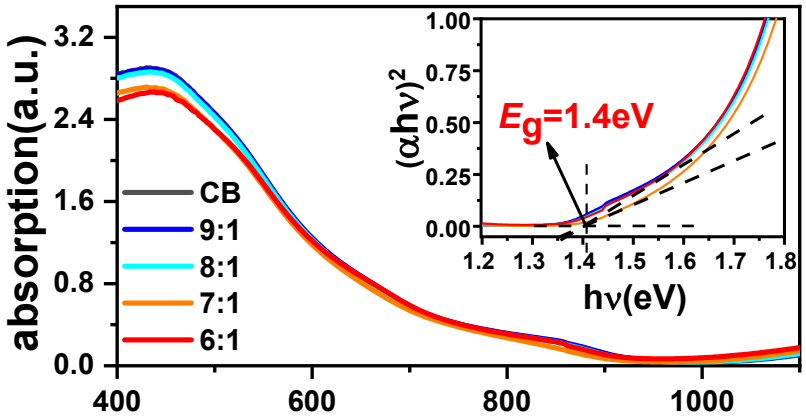

Fig. S4 UV-vis absorption spectrum of perovskite films with different proportions of antisolvent. Inset shows the Tauc plot.

Table S3. Percentage of XPS peak area of Sn^{4+} and Sn^{2+} for tin-based PSCs with different antisolvent ratios.

CB:DMS	Sn 3d5/2		Sn 3d3/2	
	Sn^{2+}	Sn^{4+}	Sn^{2+}	Sn^{4+}
CB	31.90 %	17.94 %	32.11 %	18.05 %
9:1	33.02 %	16.82 %	33.23 %	16.93 %
8:1	34.47 %	15.37 %	34.69 %	15.47 %
7:1	35.43 %	14.41 %	35.65 %	14.51 %
6:1	37.00 %	12.84 %	37.24 %	12.92 %
5:1	33.60 %	16.32 %	33.80 %	16.27 %

Table S4. Photovoltaic performance parameters of tin-based perovskite solar cells with different antisolvent ratios.

CB: DMS	V_{oc} (V)	J_{sc} (mA/cm^2)	FF (%)	PCE (%)
1:0	0.39	18.3	58.30	4.2
9:1	0.42	18.0	59.28	4.5
8:1	0.41	20.1	55.79	4.2
7:1	0.44	18.0	61.79	4.9
6:1	0.44	19.8	64.19	5.3
5:1	0.45	14.7	63.92	4.3

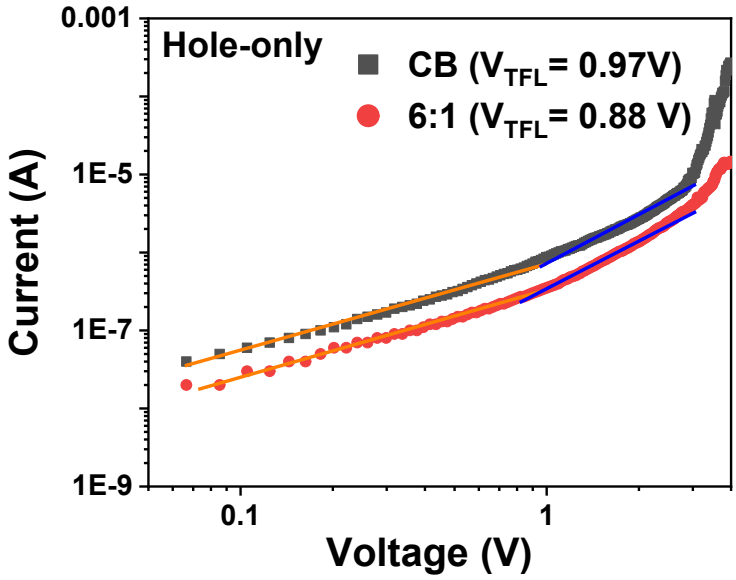

Fig. S5 SCLC curve of hole-only devices prepared with CB and CB:DMS=6:1 as anti-solvent.

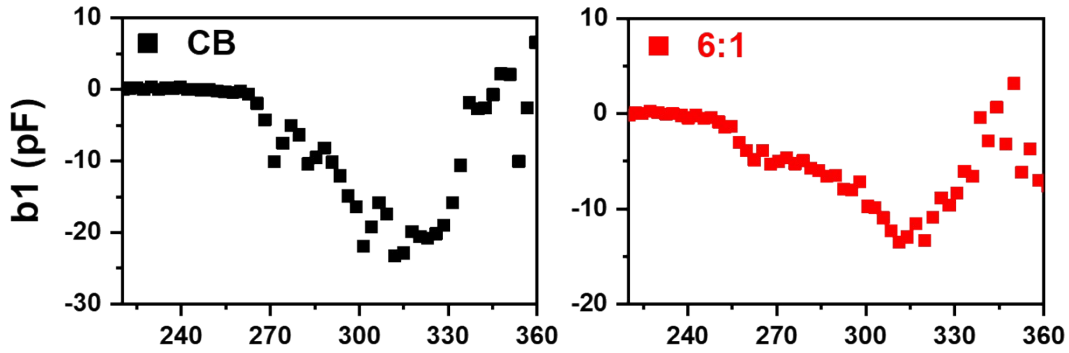

Fig. S6 Deep-level transient spectroscopy (DLTS) signal from CB device (black) and CB:DMS=6:1 device (red).

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